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USE AND AVAILABILITY OF CONTINUOUS STREAMFLOW RECORDS IN TENNESSEE

U.S. GEOLOGICAL SURVEY

Open-File Report 86-322

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by Jerry F. Lowery

U.S. GEOLOGICAL SURVEY

Open-File Report 86-322

Nashville, Tennessee
1988

UNITED STATES DEPARTMENT OF THE INTERIOR
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FACTORS FOR CONVERTING INCH-POUND TO METRIC (SI) UNITS

For the convenience of readers who prefer metric units rather than the inch-pound units used in this report, the following factors may be used.

Multiply inch-pound units	By	To obtain metric units
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	6.509	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

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ABSTRACT

This report documents the results of a data use and funding survey that is a part of a study of the cost-effectiveness of the streamflow information program in Tennessee. Presently, 88 continuous surface-water stations are operated in Tennessee with a budget of $490,800. Data uses and funding sources are identified for each of the 88 stations. Data from most stations have multiple uses.

INTRODUCTION

The U.S. Geological Survey (USGS) is the principal Federal agency collecting surface-water data in the Nation. Collection of these data is a major activity of the Water Resources Division of the USGS. The data are collected in cooperation with State and local governments and other Federal agencies. The USGS is presently (1985) operating approximately 8,000 continuous-record gaging stations throughout the Nation. At some stations, records extend back to the turn of the century. Any activity of long standing, such as the collection of surface-water data, should be reexamined periodically because of changes in objectives, technology, or external constraints. The objective of this analysis is to define and document the most cost effective means of furnishing streamflow information in Tennessee.

For every continuous-record gaging station, the analysis identifies the principal uses of the data and relates these uses to funding sources. In addition, gaging stations are categorized as to whether their data are available to users in a real-time sense, on a periodic basis, or at the end of the water year. This report is a compilation of the data uses and funding phase of the program. The second and third phases, described below, will be completed next year (1986).

The second phase of the program is to identify less costly alternative methods of furnishing needed streamflow data; among these are flow-routing models and statistical methods. Stream-gaging activity no longer is considered a network of observation points, but rather an integrated information system in which data are provided both by observation and synthesis.

The third and final phase of the program involves the use of Kalman-filtering and mathematical-programing techniques to define strategies for the operation of the necessary stations that minimize the uncertainty in the streamflow records for given operating budgets. Kalman-filtering techniques (Moss and Gilroy, 1980) are used to compute uncertainty functions (relating the standard errors of computation or estimation of streamflow records to the frequencies of visits to the stream gages) for all stations in the analysis. A steepest descent optimization program (Moss and Gilroy, 1980) uses these uncertainty functions, information on practical stream-gaging routes, the various costs associated with stream gaging, and the total District stream-gaging budget to identify the visit frequency for each station that minimizes the overall uncertainty in the streamflow. The stream-gaging program that results from this analysis will meet the expressed water data needs in the most cost-effective manner.

HISTORY OF THE STREAM GAGING PROGRAM IN TENNESSEE

In Tennessee, the stream-gaging program of the U.S. Geological Survey evolved through the years as Federal and State interest in water resources increased. The systematic collection of daily stages on larger streams in the State was begun by other Federal agencies in the 1870's. The first gaging station operated in Tennessee was located on the Tennessee River at Chattanooga (03568000) and has been in continuous operation since 1874 (table 1). Stream gaging increased very little from 1874 through 1899, with only three stations in operation at the close of that period.

In 1900, eight gaging stations were operated by the USGS in the State. Most of these stations were in East Tennessee on streams that had high potential for hydroelectric-power production. The number of gages fluctuated from 8 to 16 stations through 1918. In 1918, State cooperation increased significantly, and by 1920, 14 additional stations were in operation.

The first Survey office in Tennessee was established in 1920 in Nashville. In October of that year, a stream-gaging program was undertaken in cooperation with the U.S. Army Engineers. Financial cooperation was also arranged with various power companies. With these additional cooperators, the stream-gaging program increased to 37 gaging stations by the end of 1921. The program continued to grow through 1928 to a total of 58 gaging stations.

When the Tennessee Valley Authority (TVA) was established in 1933, the stream-gaging program was greatly expanded with the financial support of that agency. By the close of 1934, 106 gaging stations were in operation. Through the next 20 years the program changed very little fluctuating aroung 100 stations.

In 1954, a cooperative agreement was reached with the Tennessee Department of Highways to operate 85 crest-stage partial-record stations. By the end of 1955, over 200 surface-water stations were in operation; 123 of these were continuous-record stations. An

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program
[All stations are located in Tennessee except as noted]

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	CUMBERLAND RIVER BASIN			
03407908	New River at Cordell	198	October 1975-April 1977 1/, May 1977-	480 2/
03408500	New River at New River	382	August 1934-	743
03409500	Clear Fork near Robbins	272	October 1930-September 1971, July 1975 - 3/	476 4/
03410210	South Fork Cumberland River at Leatherwood Ford.	806	October 1960-September 1962, October 1978-September 1980, October 1983- 5/	6/
03410500	South Fork Cumberland River near Stearns, KY	954	September 1942-	1,792
03414500	East Fork Obey River near Jamestown	202	October 1942-	426
03416000	Wolf River near Byrdstown	106	October 1942-	193
03417500	Cumberland River at Celina	7,307	October 1922-	12,360 7/
03418070	Roaring River above Gainsboro	210	October 1974-	288
03418420	Cumberland River below Cordell Hull Dam	8,095	October 1972-	14,620 8/
03421000	Collins River near McMinnville	640	October 1924- 9/	1,167
03422500	Caney Fork near Rock Island	1,678	November 1911- 9/	3,100 10/
03425000	Cumberland River at Carthage	10,690	October 1922-	18,080 11/
03426500	Cumberland River below Old Hickory	11,735	October 1931-September 1942, October 1947- 12/	20,060 13/
03426800	East Fork Stones River at Woodbury	39.1	Water years 1932-33, 1950, 1954, 1962 14/, October 1962-	68.8

See footnotes at end of table.

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	CUMBERLAND RIVER BASIN--Continued			
03427500	East Fork Stones River near Lascassas	262	October 1950-November 1958, May 1963-	468
03428500	West Fork Stones River near Smyrna	237	October 1965-	447
03431517	Cummings Branch at Lickton	2.40	December 1975-	3.35
03431700	Richland Creek at Charlotte Avenue, at Nashville.	24.3	July 1964-	35.2
03431800	Sycamore Creek near Ashland City	97.2	October 1961-	145
03432350	Harpeth River at Franklin	191	October 1974-	327
03433500	Harpeth River at Bellevue	408	April 1920- 9/	587
03434500	Harpeth River near Kingston Springs	681	October 1924- 9/	991
03435000	Cumberland River below Cheatham Dam	14,163	October 1954-	25,540 15/
03435770	Sulphur Fork Red River above Springfield	65.6	August 1975-	109
03436000	Sulphur Fork Red River near Adams	186	October 1938- 9/	253
03436100	Red River at Port Royal	935	July 1961-	1,369
03436690	Yellow Creek at Ellis Mills	103	October 1980-	-- 6/

See footnotes at end of table.

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	TENNESSEE RIVER BASIN			
03455000	French Broad River near Newport	1,858	September to December 1900, February to August 1901, October to November 1901, November 1902-December 1905, September to December 1907, October 1920- 9/	2,996 16/
03461200	Cosby Creek above Cosby	10.1	October 1958-September 1966, October 1966- 17/	28.5
03465500	Nolichucky River at Embreeville	805	September 1900-May 1901 18/, October 1919- 9/	1,373 19/
03466228	Sinking Creek at Afton	13.7	July 1977 -	13.9
03470500	French Broad River near Knoxville	5,101	October 1945- 9/	7,991 20/
03487550	Reedy Creek at Orebank	36.3	October 1963 -	45.6
03490500	Holston River at Surgoinsville	2,874	October 1940- 9/	3,972 20/
03491000	Big Creek near Rogersville	47.3	April 1941-June 1949, October 1949-September 1955, 1957 14/, October 1954-September 1957 21/, October 1957-	59.8 22/
03491300	Beech Creek at Kepler	47.0	October 1960-September 1962, October 1963-September 1965 14/ October 1965-	51.0
03495500	Holston River near Knoxville	3,747	October 1930-June 1976 23/, January 1978-	5,075 24/
03497300	Little River above Townsend	106	October 1963-	291
03498500	Little River near Maryville	269	July 1951-	536
03528000	Clinch River above Tazewell	1,474	October 1918- 9/, 25/, 26/	2,100

See footnotes at end of table.

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	TENNESSEE RIVER BASIN--Continued			
03535000	Bullrun Creek near Halls Crossroads	68.5	October 1957-	102
03535912	Clinch River at Melton Hill Dam	3,343	September 1936 - January 1941 27/, February 1941-September 1960 28/, October 1960-September 1964 29/ October 1967-September 1968 30/, October 1978-	5,179 31/
03536550	Whiteoak Creek below Melton Valley Drive near Oak Ridge	3.28	June 1985	6/
03537100	Melton Branch at Burial Ground 7 near Oak Ridge	0.52	June 1985	6/
03538225	Poplar Creek near Oak Ridge	82.5	August 1960-	176
03538250	East Fork Poplar Creek near Oak Ridge	19.5	August 1960-	51.9
03539800	Obed River near Lancing	518	October 1956-September 1968 32/, March 1973-	1,071 33/
03540500	Emory River at Oakdale	764	June 1927-34/, 35/	1,473
03543005	Tennessee River at Watts Bar Dam	17,310	February 1934-February 1940 36/, October 1974-	29,540 37/
03543500	Sewee Creek near Decatur	117	May 1934- 38/	194
03563000	Ocoee River at Emf	524	October 1912- 9/	1,274 39/
03564500	Ocoee River at Parksville	595	January 1911-September 1916, March 1921 -	1,397 39/
03565300	South Chestuee Creek near Benton	31.8	October 1957-	52.7
03565500	Oostanaula Creek near Sanford	57.0	October 1954-	95.7

See footnotes at end of table.

Table 1.--Selected hydrologic data for stations in the Tennessee surface water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	TENNESSEE RIVER BASIN--Continued			
03566000	Hiwassee River at Charleston	2,298	November 1898-April 1899, November 1899-April 1903, October 1919-January 1940, January 1963-January 1977, September 1979-December 1981, October 1984-	4,755 40/
03566420	Wolftever Creek near Ooltewah	18.8	January 1964-	33.8
03567500	South Chickamauga Creek near Chickamauga	428	October 1928-September 1978 9/, October 1980- 41/	703
03568000	Tennessee River at Chattanooga	21,400	April 1874- 9/, 42/	37,550 43/
03571000	Sequatchie River near Whitwell	402	October 1920- 9/	748
03571850	Tennessee River at South Pittsburg	22,640	July 1930- 44/	42,940 43/
03578000	Elk River near Pelham	65.6	October 1951-	141
03584500	Elk River near Prospect	1,784	July 1904-February 1908, January 1919- 45/	3,523 46/
03588000	Shoal Creek at Lawrenceburg	55.4	June 1932-March 1934, March 1967-	108
03588400	Chisholm Creek at Westpoint	43.0	July 1962-	87.8
03588500	Shoal Creek at Iron City	348	July 1925-	651
03593500	Tennessee River at Savannah	33,140	September 1930-	52,950 47/
03596000	Duck River below Manchester	107	April 1934-	186
03598000	Duck River near Shelbyville	481	October 1933- 9/	810 48/
03600500	Big Bigby Creek at Sandy Hook	17.5	September 1953-	28.6
03602500	Piney River at Vernon	202	July 1925-	318
03603000	Duck River above Hurricane Mills	2,557	July 1925- 49/	4,615 48/

See footnotes at end of table.

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	TENNESSEE RIVER BASIN--Continued			
03604000	Buffalo River near Flat Woods	447	May 1920-	759
03604500	Buffalo River near Lobelville	707	October 1927- 9/	1,199
03605555	Trace Creek above Denver	31.9	October 1963- 50/	53.1
03606500	Big Sandy River at Bruceton	205	July 1929-	295

See footnotes at end of table

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

Station No.	Station name	Drainage area (mi^2)	Period of record	Mean annual flow (ft^3/s)
	LOWER MISSISSIPPI RIVER BASIN			
07024300	Beaver Creek at Huntingdon	55.5	Water years 1946, 1948, 1952-54, 1958-61 14/, 1954-62 21/, October 1962 -	117
07024500	South Fork Obion River near Greenfield	383	July 1929 -	594
07026000	Obion River at Obion	1,852	July 1929-September 1958, October 1966-	2,723 51/
07026370	North Reelfoot Creek at State Hwy 22 nr Clayton	56.3	May 1980-October 1983, April 1984-	6/
07026400	South Reelfoot Creek near Clayton	38.6	Water years 1955-56, 1964, 1983 1/, May 1984-	6/
07026640	Running Slough near Ledford, KY	10.8	July 1982-October 1983, April 1984-	6/
07026795	Indian Creek near Samburg	8.01	August 1982-October 1983, September 1984-	6/
07027010	Running Reelfoot Bayou near Owl City	247	July 1982-October 1983, April 1984-	6/
07029500	Hatchie River at Bolivar	1,480	July 1929-	2,436
07030240	Loosahatchie River near Arlington	262	October 1969-	368
07031650	Wolf River at Germantown	699	October 1969 52/	1,048
07032200	Nonconnah Creek near Germantown	68.2	Water years 1959-64, 1969 14/, October 1969	107

Table 1.--Selected hydrologic data for stations in the Tennessee surface-water program--Continued

[1] Discharge measurements only.
[2] Based on period 1977-84.
[3] From 1951-54, published as "Clear Fork River near Robbins."
[4] Based on periods 1931-71, 1976-84.
[5] Discharge measurements only, prior to October 1983.
[6] No mean annual flow published, less than 5 years of continuous streamflow record.
[7] Based on periods 1945-80, 1982-84.
[8] Based on discharge through Cordell Hull Dam, 1973-84.
[9] Monthly discharge only for some periods, published in Water-Supply Paper 1306.
[10] Based on period 1926-84.
[11] Based on period 1951-84.
[12] Prior to 1953, published as "at dam 3, near Old Hickory."
[13] Based on period 1957-84.
[14] Operated as a low-flow partial record station.
[15] Based on period 1969-84.
[16] Based on periods 1904-05, 1921-84.
[17] From 1959-65, published as "near Cosby."
[18] From 1900-01, published as "near Chucky Valley."
[19] Based on period 1920-84.
[20] Based on period 1954-84.
[21] Operated as a crest-stage gage.
[22] Based on periods 1942-48, 1958-84.
[23] From 1930-48, published as "at Strawberry Plains."
[24] Based on periods 1954-75, 1979-84.
[25] Prior to 1927, published as "near Lone Mountain."
[26] From August 1927 to December 1936, published as "near Tazewell."
[27] Published as "near Wheat."
[28] Published as "near Scarboro."
[29] Published as "at Melton Hill Dam."
[30] Published as near Oak Ridge.
[31] Based on periods 1968, 1979-84.
[32] Monthly discharge only for some periods, published in Water-Supply Paper 1726.
[33] Based on periods 1957-68, 1974-84.
[34] Prior to October 1929, published as "Emery River at Harriman."
[35] From Oct 1929 to September 1934, published as "Emery River at Oakdale."
[36] Published as "at Breedenton."
[37] Based on period 1975-84.
[38] Prior to October 1935, published as "Suee Creek near Decatur."
[39] Based on period 1943-84.
[40] Based on periods 1964-76, 1980-81.
[41] Prior to 1937, published as "Chickamauga Creek near Chickamauga."
[42] Records for July 1930 to December 1935 are from station " at Hales Bar, near Chattanooga."
[43] Based on period 1962-84.
[44] From 1930-66, published as "at Hales Bar, near Chattanooga."
[45] Prior to 1934, published as "near Elkmont, Alabama."
[46] Based on period 1972-81.
[47] Based on period 1946-84.
[48] Based on period 1977-82.
[49] Prior to 1951, published as "near Hurricane Mills."
[50] Prior to 1972, published as "near Denver."
[51] Based on periods 1930-58, 1967-84.
[52] Prior to 1978, published as "near Germantown."

agreement was reached with the State Department of Public Health in 1958 to operate 35 low-flow partial-record stations. These additional stations increased the surface-water program to 240 stations. Growth continued into the sixties and continuous record station operation peaked with 135 stations in 1967 and 1968. In 1968, total surface-water station operation reached a high with 441 stations, 145 low-flow and 161 crest-stage partial record stations along with the 135 continuous record stations.

An evaluation of the surface-water program was made in 1970 (May, and others), and recommendations were made for modifying the existing network to meet the future needs of water-data users. Recommendations from this study were made to discontinue 16 continuous gaging stations. At the close of 1971, 113 continuous stations were in operation. The surface-water program remained relatively stable through 1978, fluctuating from a high of 112 continuous-record stations in 1978 to a low of 103 stations in 1976. In 1979, a coal-hydrology study was started to monitor flow in the coal mined areas of east Tennessee. At the end of this project in 1981, 399 surface-water stations were in operation. These included 114 continuous-record stations, 127 crest-stage, 77 low-flow, and 81 coal-hydrology partial-record stations. Since 1982 budget restraints on most cooperating agencies, especially TVA, has caused the continuous record program to drop to its lowest level since 1931. The total 1985 surface-water program consists of 260 stations as follows: (1) 88 continuous discharge; (2) 2 continuous lake stage; (3) 5 flood hydrograph; (4) 75 low-flow partial-record; (5) 84 crest-stage partial-record; and (6) 6 flood-profile partial-record stations. The historical numbers of continuous stream gages operated in Tennessee are given in figure 1.

Current Tennessee Stream-Gaging Program

Tennessee lies in part of seven physiographic provinces noted by Fenneman (1938) as the Coastal Plain, Highland Rim, Central Basin, Cumberland Plateau, Sequatchie Valley, Valley and Ridge, and Blue Ridge. The locations of these provinces and the distribution of the 88 continuous stream gages currently operated by the Tennessee District of the Geological Survey are shown in figure 2. Twenty-four gages are in the Valley and Ridge, 23 are in the Highland Rim, 14 are in the Coastal Plain, 13 are in the Central Basin, 8 are in the Cumberland Plateau, 4 are in the Blue Ridge, and 2 are in the Sequatchie Valley. For many gages, the drainage area overlaps two or more provinces. The gages are fairly well distributed physio-graphically (fig. 2), but there are large areas within the Coastal Plain and Cumberland Plateau where no gaging stations are currently being operated.

Table 1 provides the official name and eight-digit downstream-order number of each of the 88 continuous stream gages in the Tennessee program. Selected hydrologic data for each station, including drainage area, period of record, and mean annual flow are also given in table 1.

The cost of operating these 88 stream gages in fiscal year 1985 was $490,800.

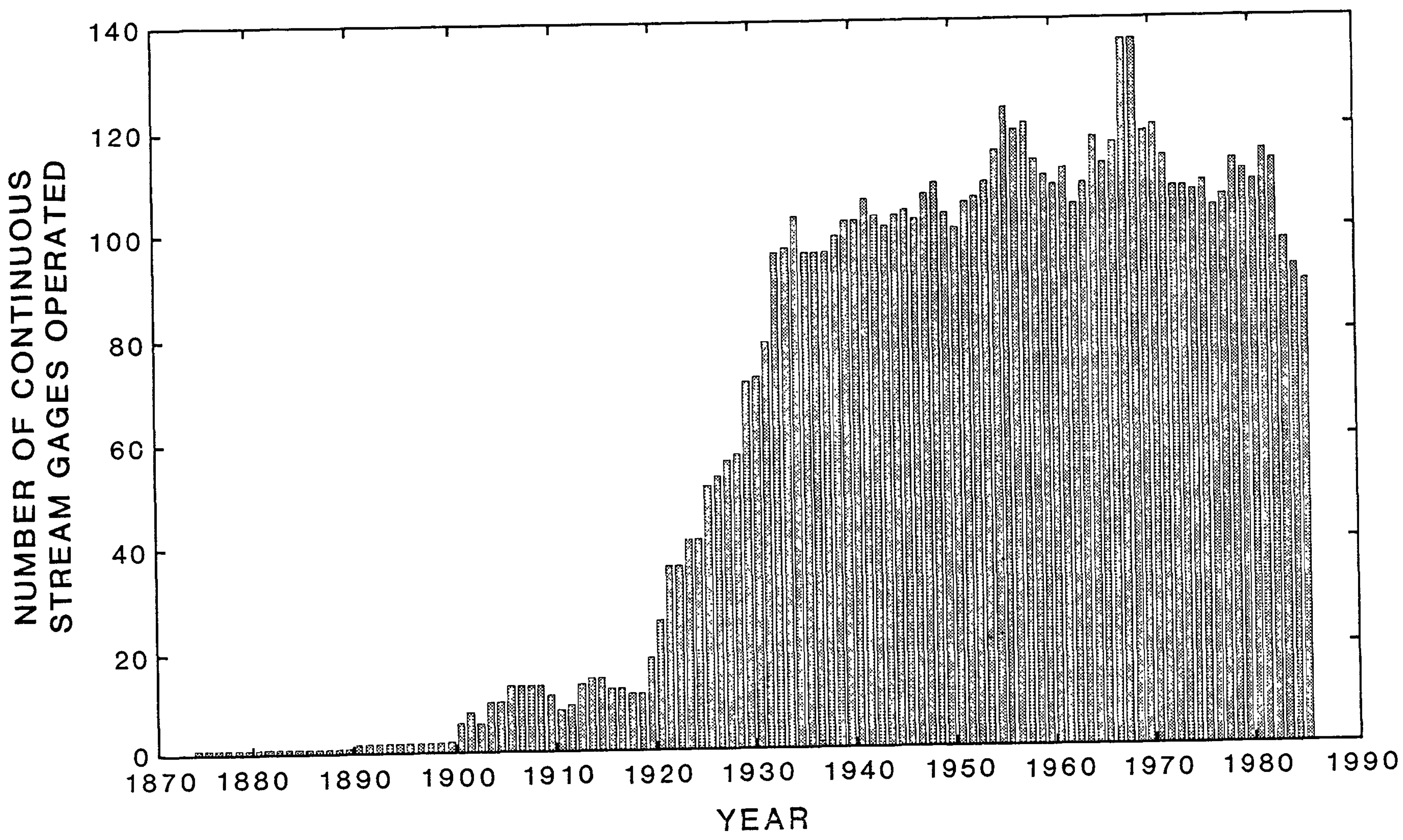


Figure 1.--History of continuous stream gaging in Tennessee.

USES, FUNDING, AND AVAILABILITY OF CONTINUOUS STREAMFLOW DATA

The relevance of a stream gage is measured by the uses that are made of the data that are produced by the gage. In the Tennessee program, potential uses of the data from each new gage are identified prior to gage installation and continue to be documented through informal discussions and formal program meetings with cooperators and other possible funding sources. Geological Survey hydrologists' knowledge of other data users requests are also used to assist in the determination of the relative importance of each gage.

Identified data uses are categorized into nine classes, defined below. The sources of funding for each gage and the frequency at which data are provided to users are also compiled.

DATE–USE CLASSES

The following definitions are used to categorize each known use of streamflow data for each continuous stream gage.

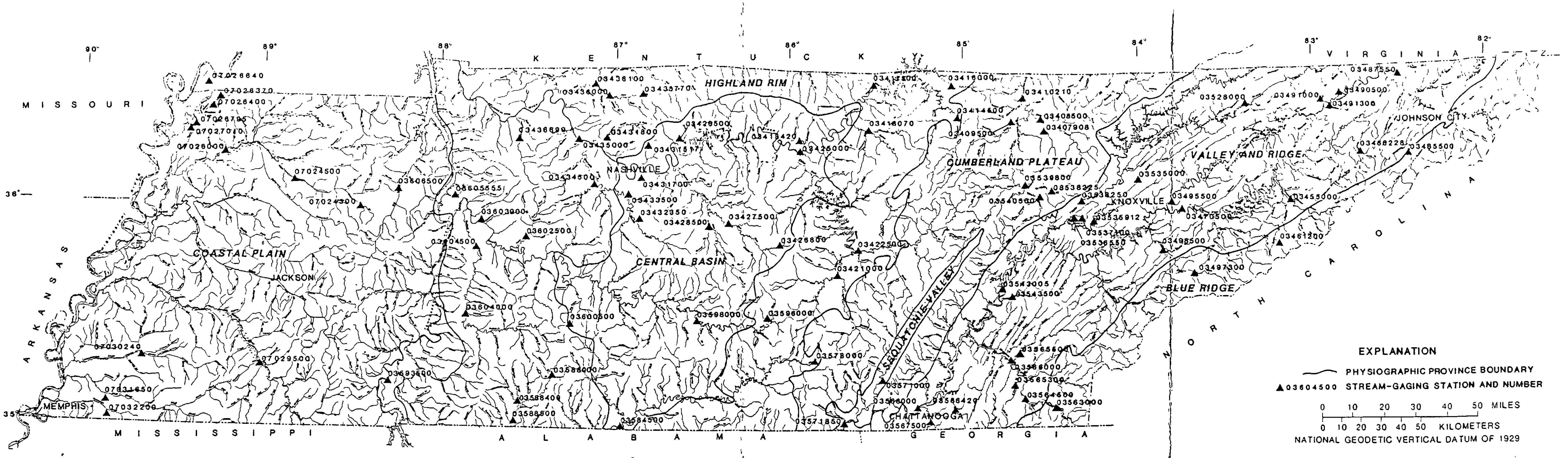
Regional Hydrology

For data to be useful in defining regional hydrology, a stream gage must be largely unaffected by manmade storage or diversion. In this class of uses, the effects of man on streamflow are not necessarily small, but the effects are limited to those caused primarily by land use. Large amounts of manmade storage may exist in the basin and not destroy usefulness of the data if the outflow from storage is uncontrolled. These stations are useful in developing regionally transerrable information about the relations between basin characteristics and streamflow.

Sixty stations in the Tennessee network are classified in the regional hydrology data-use category. Nine of these stations are special cases in that they are designated as benchmark or as index stations. Hydrologic benchmark stations, of which there are two in Tennessee, were established nationwide to indicate hydrologic conditions of watersheds that are relatively free of manmade alteration. Four of the seven index stations are designated as long term and are similar to benchmark stations in that they are relatively free of manmade alteration and are located to provide regional coverage. They are intended to provide a basis for time-sampling error adjustment of short-term flow records and for the definition of hydrologic trends. They are also used as a reference for noting manmade changes in other watersheds where development is occurring. These stations are well distributed areally and are in basins having different physical characteristics. Three of the index stations, widely separated within the State, are part of the national water conditions network and are used to indicate current hydrologic conditions. The locations of stream gages that provide information about regional hydrology are shown on figure 3.

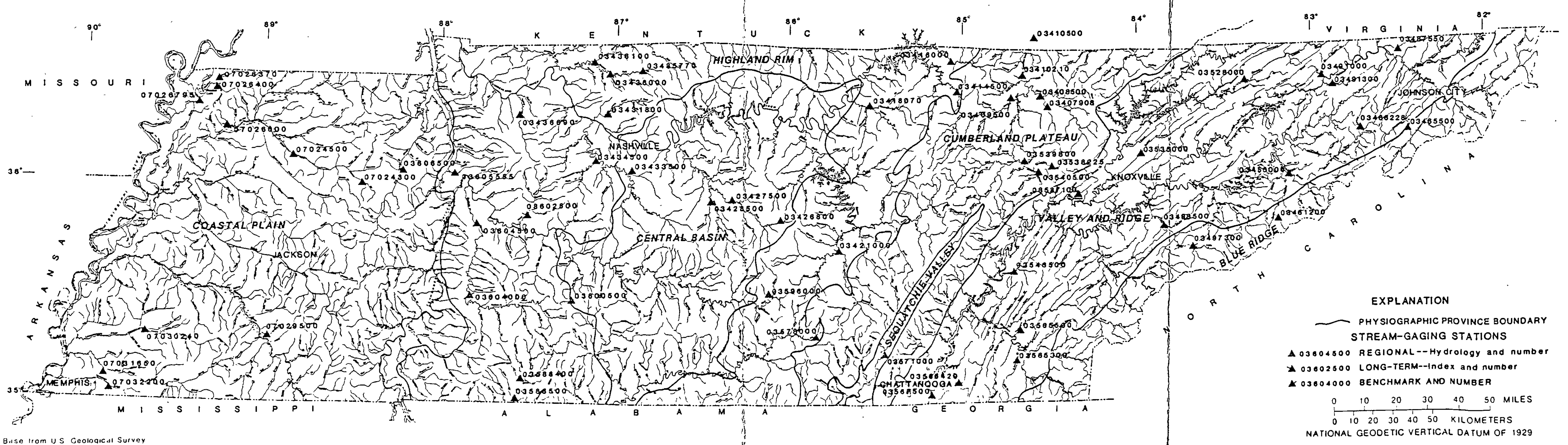
Hydrologic Systems

Stations that can be used for accounting, that is, to define current hydrologic conditions and the sources, sinks, and fluxes of water



Base from U.S. Geological Survey State base map, 1:1,000,000, 1957, revised 1973

Figure 2.--Location of stream gages and physiographic provinces.



Base from U.S. Geological Survey State base map 1:1,000,000 1957 revised 1973

Figure 3.--Location of regional hydrology stream gages and physiographic provinces.

through hydrologic systems including regulated streams, are designated as hydrologic systems stations. They include stations affected by diversions and return flows and other stations that are useful for defining the interaction of water systems.

Thirty-four stations are classified in the hydrologic systems data-use category. The benchmark and index stations are included in the hydrologic-systems category because they are accounting for current and long-term conditions of the hydrologic systems that they gage.

Seventeen stations provide data at strategic points within regulated systems. In addition, four stations are included which are operated for a water budget study of Reelfoot Lake and two stations for a base flow-groundwater study at the Department of Energy's Oak Ridge Reservation. These six stations will be discontinued or reclassified at the completion of these studies. Two stations included in this category are used to monitor flow of waste-water and effluent discharges.

Legal Obligations

Some stations provide records of flows for the verification or enforcement of existing treaties, compacts, and decrees. The legal obligation category contains only those stations that the Geological Survey is required to operate to satisfy a legal responsibility.

There are no stations in the Tennessee program that exist to fulfill a legal responsibility of the Geological Survey.

Planning and Design

Gaging stations in this category are used to plan and design a specific project (for example, a dam, levee, floodwall, navigation system, water-supply diversion, hydropower plant, or waste-treatment facility) or group of structures. The planning and design category includes stations in operation at strategic locations prior to the advent of specific project planning and those stations that were instituted for such purposes, where those purposes are still valid.

Currently, 14 stations in the Tennessee program are being operated for planning or design purposes. There is one gage at each of three water-supply studies, five stations are used in a lake sedimentation study, and six stations are used in planning dredging operations. In addition, five stations are used in a dendrogeomorphological study of bank stability in order to design bridges and culverts on streams with unstable bank properties.

Project Operation

Gaging stations in this category are used, on an ongoing basis, to assist water managers in making operational decisions such as reservoir releases, hydropower operations, or diversions. The project-operation use generally implies that the data are routinely available to the operators on a rapid-reporting basis. For projects on large streams, data may only be needed at intervals of a few days.

There are 30 stations in the Tennessee program that are used in this manner. All of

these are used to assist in the management of reservoirs and (or) the production of electric power.

Hydrologic Forecasts

Gaging stations in this category are regularly used to provide information for hydrologic forecasting. These might be flood forecasts for a specific river reach, or periodic (daily, weekly, monthly, or seasonal) flow volume forecasts for a specific site or region. The hydrologic forecast use generally implies that the data are routinely available to the forecasters on a rapid-reporting basis. On large streams, data may only be needed at intervals of a few days.

There are 18 stations in the Tennessee program that are included in this data-use category. All but one of these stations are equipped with telemetry devices. Data from these stations are used by the U.S. National Weather Service (NWS) to forecast floodflows at specific sites.

Water-Quality Monitoring

Gaging stations where regular water-quality or sediment-transport monitoring is conducted and where the availability of streamflow data contributes to the utility or is essential to the interpretation of the water-quality or sediment data are designated as water-quality monitoring sites.

There are 21 stations in the Tennessee network classified in the water-quality monitoring data-use category. One such station in the program is designated a benchmark station and nine others are National Stream Quality Accounting Network (NASQAN) stations. The benchmark and one NASQAN station are also in the Radiochemical Surveillance Program. Water-quality samples from benchmark stations are used to indicate water-quality characteristics of streams that have been, and probably will continue to be, relatively free of manmade influence. NASQAN stations are part of a nationwide network designed to assess water-quality trends of significant streams. The Radiochemical program is a network of regularly sampled water-quality stations where samples are collected to be analyzed for radioisotopes. In addition, four stations are operated to monitor the quality of flow through a National River and Recreational area, two to monitor the quality of outflow from a reservoir and two to monitor the quality of inflow to a reservoir. Sediment data are collected at the benchmark, NASQAN, the four stations monitoring flow through the National River and Recreational Area and at three sites monitoring flow into a natural lake in northwestern Tennessee.

Research

Gaging stations in this category are operated for a particular research or water-investigations study. Typically, research stations are operated as such only for the duration of a study and then, if continued for other purposes, are appropriately reclassified.

There are two flood runoff and rainfall stations in the Tennessee program. These stations

are used to develop or verify models for flood-frequency analysis.

Other

In addition to the eight data-use classes described above, 13 stations incidentally are used to provide streamflow information for recreational planning, primarily for canoeists, rafters, and fishermen.

FUNDING

The four sources of funding for the streamflow-data program are:

- Federal program.--Funds that have been directly allocated to the Geological Survey.

- Other Federal Agency (OFA) program.--Funds that have been transferred to the Geological Survey by OFA's.

- Coop program.--Funds that come jointly from Geological Survey and from a non-Federal cooperating agency (joint-funding agreement). Cooperating agency funds may be in the form of direct services or cash.

- Other non-Federal.--Funds that are provided entirely by a non-Federal agency or a private source under the auspices of a Federal agency. In this study, private funds are limited to those from public service companies engaged in the production of electric power. Funds in this category are not matched by the Geological Survey through joint-funding agreements.

In all four categories, the identified sources of funding pertain only to the collection of streamflow data; sources of funding for other activities at the site, particularly collection of water-quality samples, may not necessarily be the same as those identified herein.

Nine entities currently are contributing funds to the Tennessee stream-gaging program.

FREQUENCY OF DATA AVAILABILITY

Frequency of data availability refers to the times at which the streamflow data may be furnished to the users. In this category, three distinct possibilities exist. Data can be furnished by direct-access telemetry equipment, by periodic release in provisional form, or by publication in the annual data report for Tennessee (U.S. Geological Survey, 1984). These three categories are designated T, P, and A, respectively, in table 2. In the current Tennessee program, data for all 88 stations are published in the annual report, real-time data are available from 29 stations, and provisional data are routinely available for 5 stations and are available upon request for the other stations.

DATA-USE PRESENTATION

Data-use and ancillary information are presented for each continuous-gaging station in table 2, which contains footnotes to expand the information conveyed. An asterisk in the table denotes data available for the indicated category.

SUMMARY

At present (1985) there are 88 continuous gages being operated on rivers and streams in Tennessee at a cost of $490,800. A review of the data use and funding information presented in table 2 indicates that the data from most stations in the Tennessee network have multiple uses. Many of the gaging stations are used on an ongoing basis for accounting and for project operation. Although stations may have been established for one specific purpose, availability has, in itself, produced other uses for the data.

REFERENCES CITED

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Moss, M. E., and Gilroy, E. J., 1980, Cost-effective stream-gaging strategies for the Lower Colorado River Basin: U.S. Geological Survey Open-File Report 80-1048, 112 p.

U.S. Geological Survey, 1984, Water resources data Tennessee, water year 1984: U.S. Geological Survey Water-Data Report TN-84-1, 331 p.

Table 2.--Data-use table

[* indicates available data]

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03407908	*											1		A
03408500	*						1 2		3		2	1		A
03409500	*						1 2		3	4	2	1		A
03410210	*						2		3		2			A
03410500	*						2		3		2			A
03414500	*				5 6						2	1		A, T
03416000	*				5 6						2	1		A, T
03417500		2			5 6	7					2	1		A, T
03418070	*				5 6						2			A, T
03418420					5 6		2				2			A, T, P
03421000	8	8			5 6						9			A, T
03422500					5 6						9 2			A

[1]Tennessee Department of Health and Environment
[2]U.S. Corps of Engineers, Nashville District
[3]Recreational use
[4]Army Engineer replacement funds
[5]Multipurpose reservoir system operation, U.S. Corps of Engineers, Nashville District
[6]Southeast Power Administration, hydropower system operation
[7]Flood forecasting - U.S. National Weather Service
[8]Long-term index gaging station
[9]Tennessee Valley Authority

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03425000		2			5 6	7	10			*	2			A, T
03426500		2			5 6		2				2	1		A, T
03426800	*											1		A
03427500	*				5		2				2			A, T
03428500	*				5		2				2			A, T
03431517								11				12		A
03431700								11				12		A
03431800	*											1		A
03432350						7				4	2			A, T
03433500	*										2	1		A
03434500	13	13				7					2	1		A, T

[1]Tennessee Department of Health and Environment
[2]U.S. Corps of Engineers, Nashville District
[4]Army Engineer replacement funds
[5]Multipurpose reservoir operation, U.S. Corps of Engineers, Nashville District
[6]Southeast Power Administration, hydropower system operation
[7]Flood forecasting - U.S. National Weather Service
[10]NASQAN station
[11]Urban Hydrology Studies
[12]Metropolitan Government of Nashville and Davidson County
[13]National water-conditions network

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03435000		2			5						2			A
03435770	*											1		A
03436000	*										2	1		A
03436100	*					7					2			A, T
03436690	*									4	2	1		A, T
03455000	*				14	7			3	*		1		A, T
03461200	*											1		A
03465500	*				14	7			3		9	1		A, T
03466228	*											1		A
03470500		9					10			*				A
03487550	*											1		A
03490500		9										1		A

[1]Tennessee Department of Health and Environment
[2]U.S. Corps of Engineers, Nashville District
[3]Recreational use
[4]Army Engineer replacement funds
[5]Multipurpose reservoir operation, U.S. Corps of Engineers, Nashville District
[7]Flood forecasting - U.S. National Weather Service
[9]Tennessee Valley Authority
[10]NASQAN station
[14]Multipurpose reservoir system operation, Tennessee Valley Authority

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03491000	8	8								*	9	1		A
03491300	*											1		A
03495500		9			14		10			*		1		A
03497300	15	15								*				A
03498500	*			16	14				3		9	1		A, T
03528000	*				14	7			3	*	9			A, T
03535000	*										9	1		A
03535912		9			14		10			*				A
03536550		17									17			A
03577100	*	17									17			A
03538225	*											1		A
03538250		18										1		A

1 Tennessee Department of Health and Environment
3 Recreational use
7 Flood forecasting - U.S. National Weather Service
8 Long-term index gaging station
9 Tennessee Valley Authority
10 NASQAN station
14 Multipurpose reservoir system operation, Tennessee Valley Authority
15 Hydrologic benchmark station
16 Water-supply system, cities of Maryville and Alcoa
17 U.S. Department of Energy
18 Compliance of waste-water and effluent discharges, Tennessee Dept. of Health and Environment

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03539800	*											1		A
03540500	13	13			14	7			3	*	9			A, T
03543005		9					10			*				A
03543500	*										9	1		A
03563000		9			14				3		9	1		A
03564500		9			14				3		9	1		A
03565300	*										9	1		A
03565500	*											1		A
03566000		18										1		A
03566420	*											1		A
03567500	*				14						9	1		A, T
03568000		9			14					*	9			A, T

[1]Tennessee Department of Health and Environment
[3]Recreational use
[7]Flood forecasting - U.S. National Weather Service
[9]Tennessee Valley Authority
[10]NASQAN station
[13]National water-conditions network
[14]Multipurpose reservoir system operation, Tennessee Valley Authority
[18]Compliance of waste-water and effluent discharges, Tennessee Dept. of Health and Environment

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03571000	*				14	7					9	1		A, T
03571850		9					10 19			*				A
03578000	*											1		A
03584500		9			14	7					9	1		A, T
03588000				20								20		A
03588400	*											1		A
03588500	*				14	7					9	1		A, T
03593500		9			14		10			*	9			A, T
03596000	*				14							1		A, T
03598000		9			14	7					9	1		A, T
03600500	*											1		A
03602500	8	8		21						*		1		A

[1]Tennessee Department of Health and Environment
[7]Flood forecasting - U.S. National Weather Service
[8]Long-term index gaging station
[9]Tennessee Valley Authority
[10]NASQAN station
[14]Multipurpose reservoir system operation, Tennessee Valley Authority
[19]National radiochemical surveillance program
[20]Water-supply system, city of Lawrenceburg
[21]Water-supply system, city of Dickson

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
03603000		9			14	7					9			A, T
03604000	15	15				7	15 19		3	*				A
03604500	13	13				7			3		9			A, T, P
03605555	*											1		A
03606500	*											1		A
07024300	*			22								1		A
07024500	*			22 23								1		A
07026000	*			22 23			10			*				A
07026370	*	25 26		24 25 26			24 25 26					1		A
07026400	*	25 26		24 25 26			24 25 26					1		A
07026640		25 26		24 25 26			24 25 26					1		A
07026795	*	25 26		24 25 26								1		A

[1]Tennessee Department of Health and Environment
[3]Recreational use
[7]Flood forecasting - U.S. National Weather Service
[9]Tennessee Valley Authority
[10]NASQAN station
[13]National water-conditions network
[14]Multipurpose reservoir system operation, Tennessee Valley Authority
[15]Hydrologic benchmark station
[19]National radiochemical surveillance program
[22]U.S. Corps of Engineers, Memphis District, West Tennessee tributary dredging project
[23]Tennessee Department of Transportation, Dendro-geomorphic hydrology
[24]U.S. Corps of Engineers, Memphis District, Reelfoot Lake sedimentation and water availability study
[25]U.S. Fish and Wildlife Service, Reelfoot Lake sedimentation and water availability study
[26]Tennessee Wildlife Resource Agency, Liminology study

Table 2.--Data-use table--Continued

Station Number	DATA USE									FUNDING				Frequency of Data Availability
	Regional Hydrology	Hydrologic Systems	Legal Obligations	Planning & Design	Project Operation	Hydrologic Forecasts	Water-quality Monitoring	Research	Other	Federal Program	OFA Program	Co-op Program	Other Non-Federal	
07027010				24 25 26								1		A
07029500	8	8				7	10 22			*		1		A
07030240	*			22 23 27								27		A, P
07031650	*			22 23 27		7						27		A, T, P
07032200	*			22 23 27								27		A, P

[1]Tennessee Department of Health and Environment
[7]Flood forecasting - U.S. National Weather Service
[8]Long-term index gaging station
[10]NASQAN station
[22]U.S. Corps of Engineers, Memphis District, West Tennessee tributary dredging project
[23]Tennessee Department of Transportation, Dendro-geomorphic hydrology
[24]U.S. Corps of Engineers, Memphis District, Reelfoot Lake sedimentation and water availability study
[25]U.S. Fish and Wildlife Service
[26]Tennessee Wildlife Resource Agency, Liminology study
[27]Shelby County

Lowery

USE AND AVAILABILITY OF CONTINUOUS STREAMFLOW RECORDS IN TENNESSEE

USGS/OFR 86-322